

# Reliability Test Station

**Update**

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Electrical & Computing Engineering

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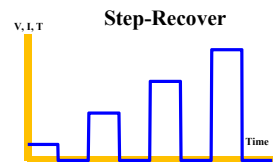
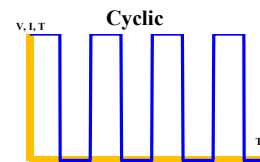
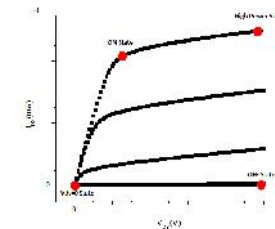
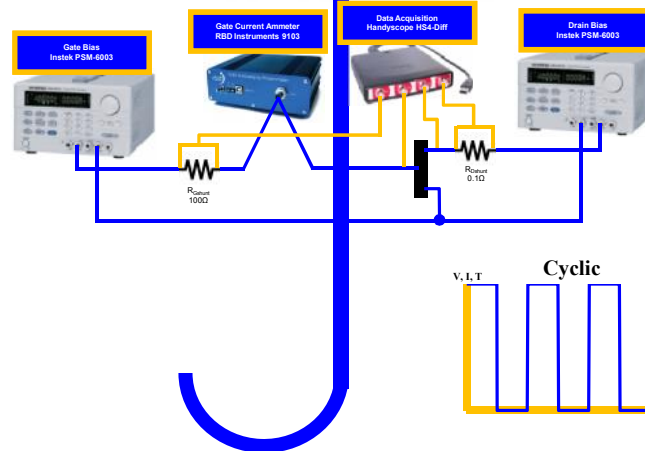
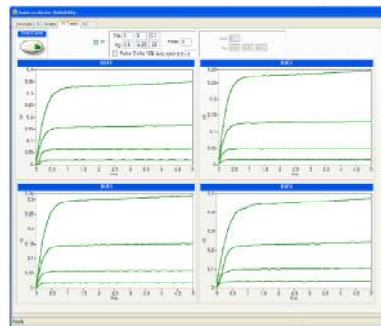
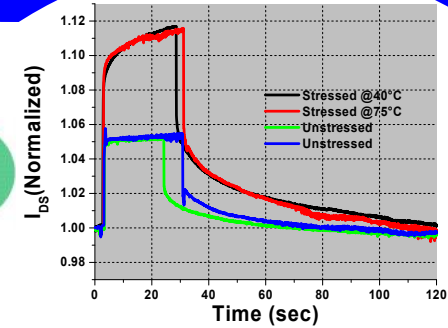
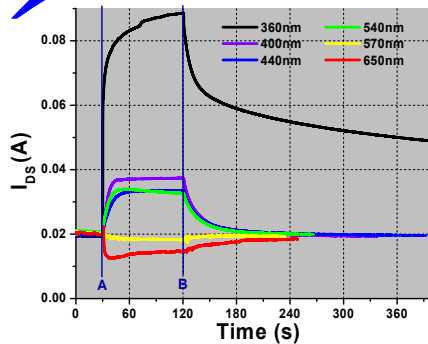
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# Reliability Test Station

## FLOORS



$t=0$ , As Built

$t>0$ , Degradation

# Motivation

	Turnkey		In-house
Timeline	Purchase lead time		On-going
System	Proven/Widely-used		Custom design
Objective	Predict life expectancy		Research Determine failure mechanisms
Test Types	Life Test/Burn-in		<b>FLEXIBLE</b>
DC	Drain Gate	0-100V, up to 4A, 400W max ±18.5V, up to 200mA	0-60V, up to 6A, 300W max ±60V, up to 6A
	RF	600MHz-3 GHz 2-18 GHz 58-60 GHz	900MHz-10GHz 36-40 GHz 76-78 GHz
	Temperature	50° to 250° C	25° to 150° C
	Optical	?	Research with wavelength and intensity
	Pulse	1-100kHz	1-100kHz+
Data Storage	Independent test files		SQL database

# System Specifications & Features

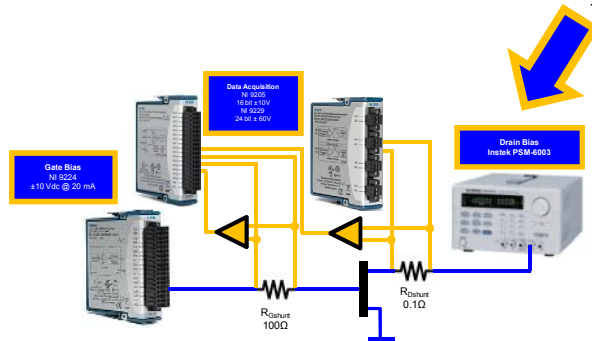
32 Device Capacity Identical



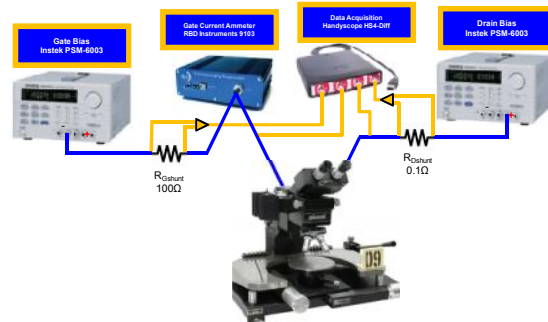
16 Device Capacity Identical



11+ Device Capacity



8 Device



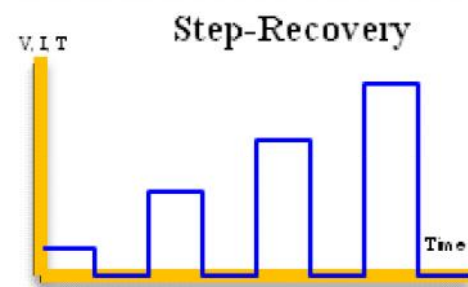
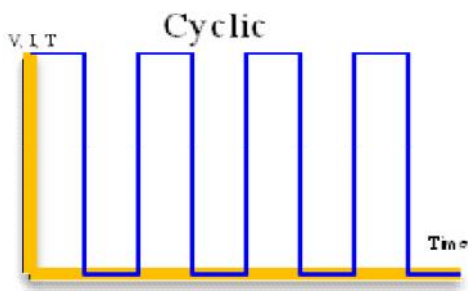
2 Device

# System Specifications & Features

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- Individual device control
  - Gate bias
    - $\pm 10\text{Vdc}$  up to 20mA
    - 0-60Vdc, 6A max, 300W max
  - Drain bias
    - 0-60Vdc, 6A max, 300W max
    - Over-current & over-voltage protection
  - Temperature
    - 25-150° C Peltier heating
    - PID control
- Controlled in groups of 4

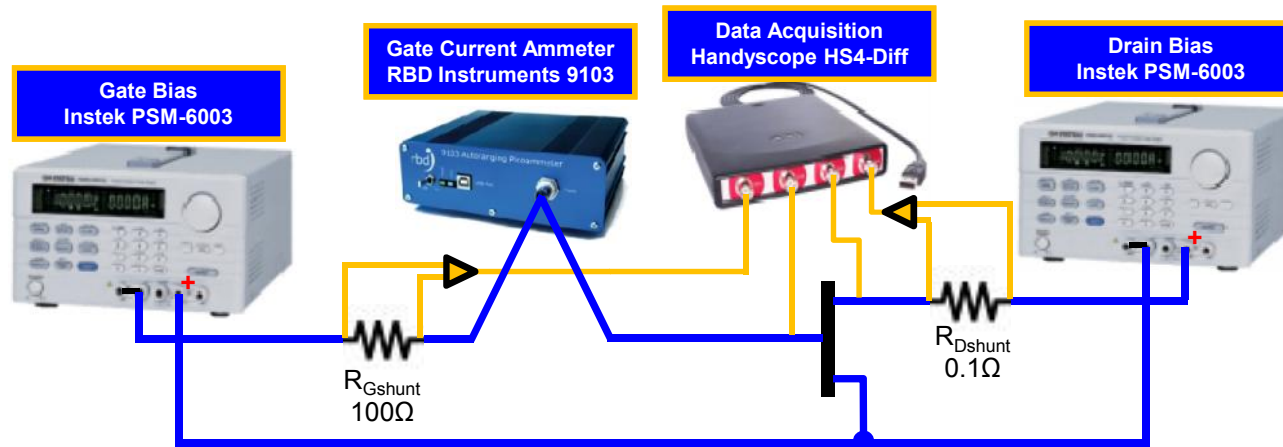
# System Specifications & Features



- Long-term DC Stress
  - Types
    - Stress-recovery
    - Step-stress
    - Step-recovery
- Device Characteristics
  - IV curve, Gate & Drain
- Gate Pulse Test (Gate Lag)
- Optical Pumping



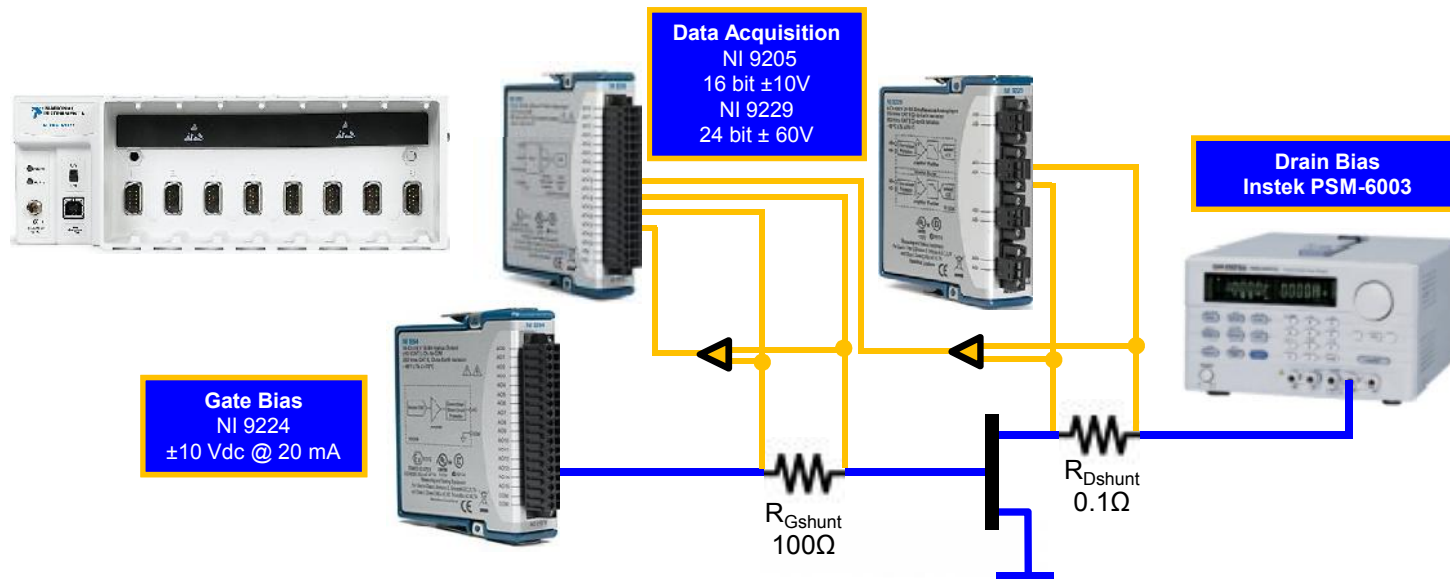
# System Hardware



## Uber-station

- 50MHz sampling
- fA resolution on gate current
- $\pm 60V$  Gate Bias

# System Hardware

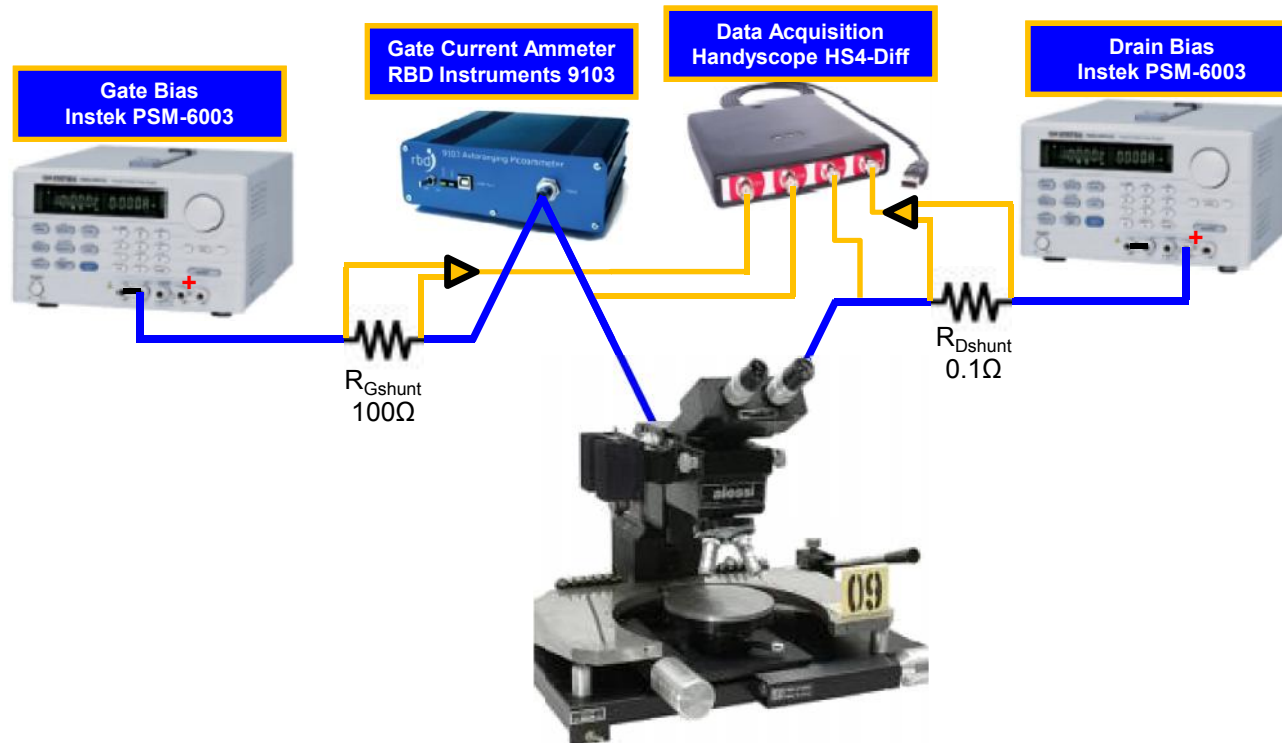


## Long-term stations

- 50kHz sampling
- $\pm 10$ V Gate Bias
- 60V Drain Bias (300W)



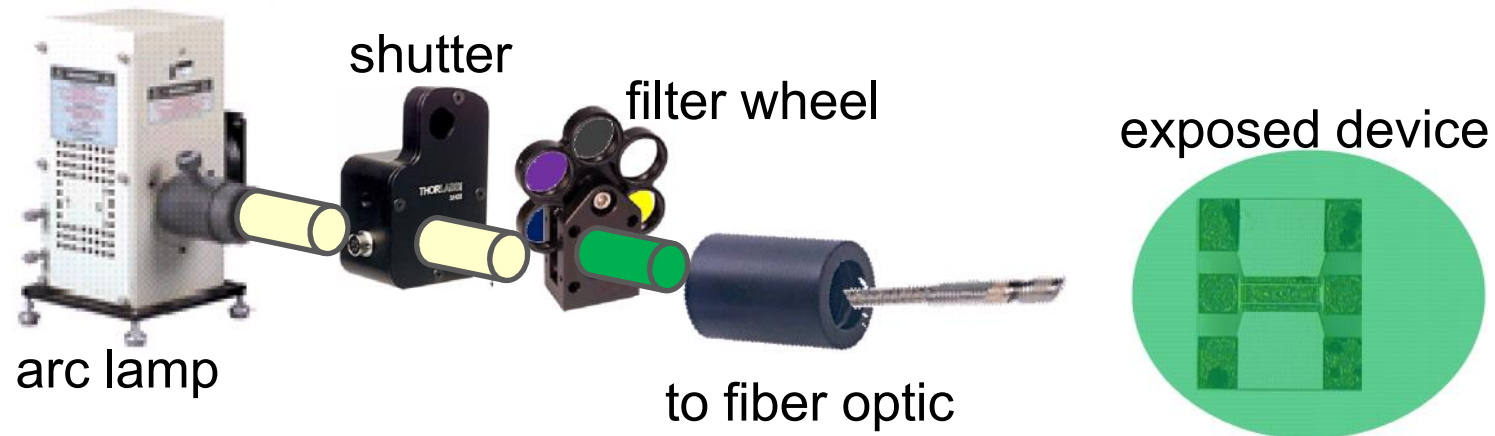
# System Hardware



## Probe-station

- Uber with probe capabilities
- Optical pumping

# System Hardware

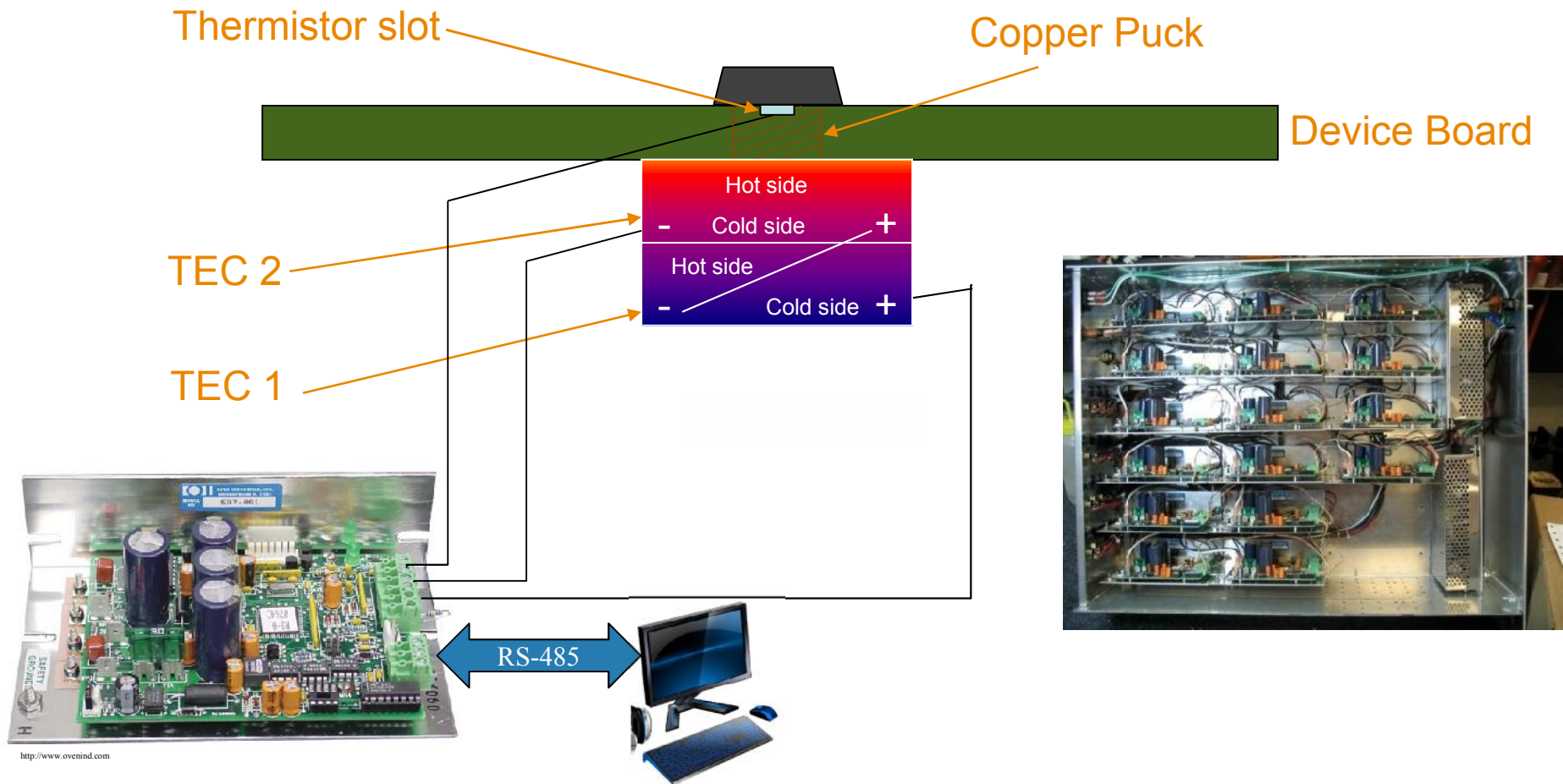


## Optical

- 200-500W Mercury Arc
- Band-pass filters
- UV LED (in development)

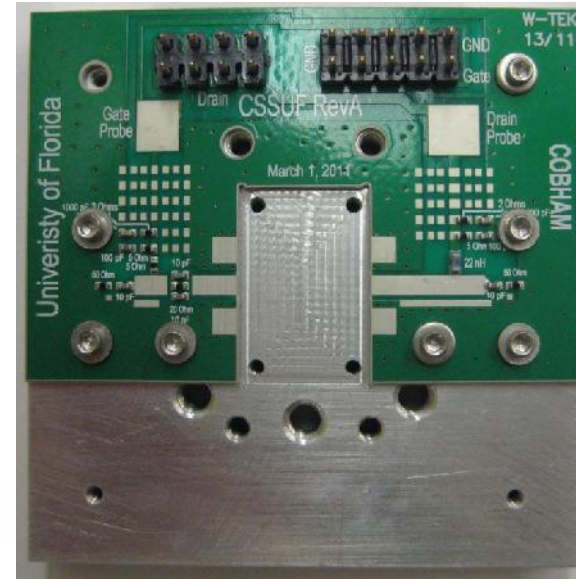
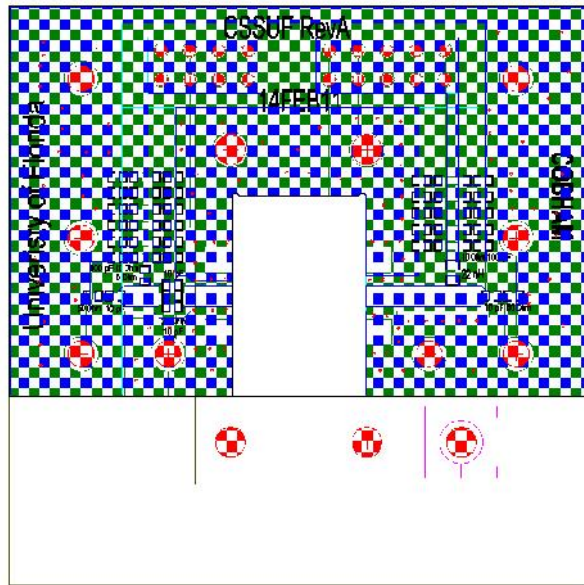
Wavelength	Color	Energy (eV)
650nm	Red	1.9
570nm	Yellow	2.2
540nm	Green	2.3
440nm	Blue	2.8
400nm	Violet	3.1
360nm	Near UV	3.4
Hg Full spectrum	1100nm to UV	Above band gap

# System Hardware



## Temperature Measurement and Control

# System Hardware

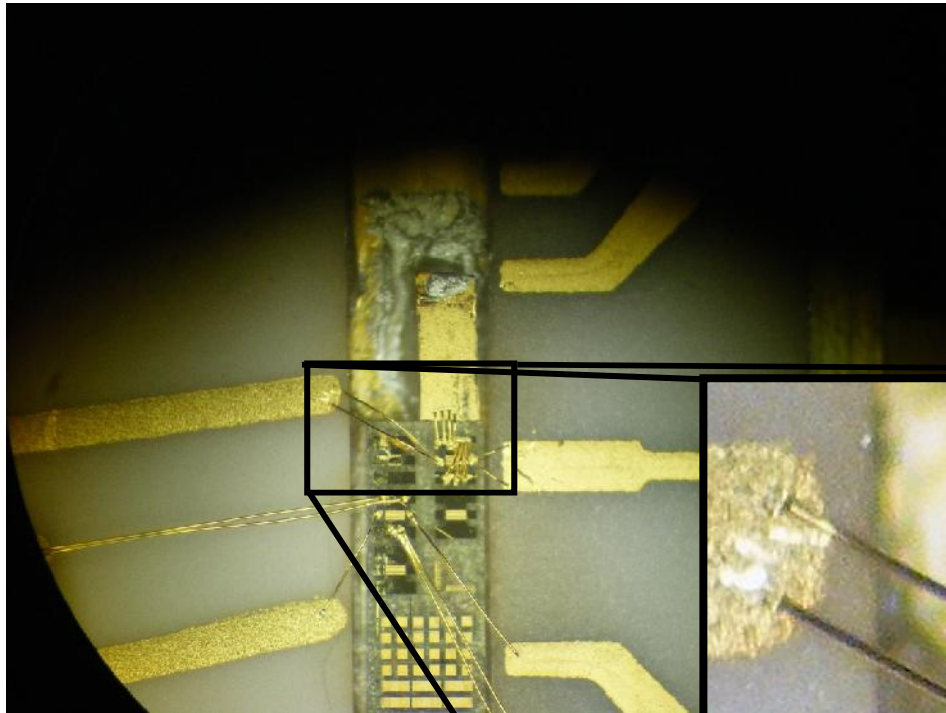


## DUT Boards

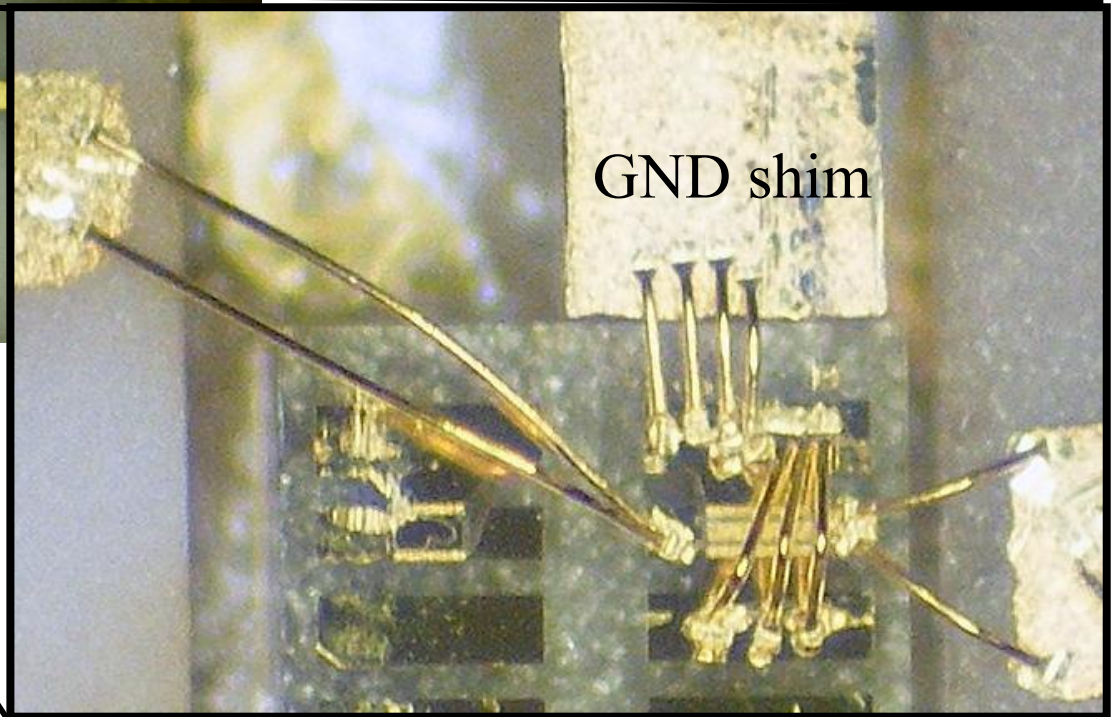
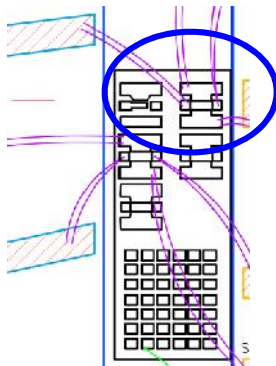
- Cobham Sensor Systems
- Package re-work
- 50Ω termination and bias-Tee



# System Hardware



- Shim placed next to device as close as possible to provide a common package ground point
- Short source straps and bonds to ground



# Future Work

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## Version 2 Control

- Constant current testing
- Degradation metrics (% change or level)
  - $I_D$  with constant  $V_D$
  - $V_D$  with constant  $I_D$
  - $I_G$  leakage
  - $R_{CH}$ ,  $R_D$ , or  $R_S$
  - Shifts in threshold voltage  $V_T$
- Measurement Suite

[J. Joh, “Degradation Mechanisms of GaN High Electron Mobility Transistors,” MS thesis, MIT, 2007]

  - $V_D$ ,  $I_D$ ,  $V_G$ ,  $I_G$ , Temperature
  - $R_{CH}$ ,  $R_D$ ,  $R_S$ , or  $R_{TOT}$  trending
  - Trending at specific bias points
    - $I_{Dmax}$ ,  $I_{Dmin}$ ,  $I_{Dss}$ ,  $V_G$ ,  $V_{Gpk}$ ,  $V_{Gon}$ ,  $I_G$ ,  $I_{Goff}$ ,  $I_{GVT}$ , Temperature
  - $g_{mpk}$ ,  $V_T$ , SS, DIBL
- Sequencing